Labor Market Dynamics after Cost-of-Living Shocks

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Monge-Ludwig WG - 02.06.2025

Introduction

- Renewed interest in the distributional impact of relative price changes
  - For instance, because of income-gradient in energy and food expenditure shares
  - More broadly: price change for goods with low demand elasticities (CoL shocks)
- This project: study relevance of endogenous labor market adjustments as mitigator
  - Do adjustments in nominal earnings compensate for cost increases?
  - What are the channels? (job mobility, bargaining, labor demand, ...)

Overview and Findings

- Focus on the case of energy prices and exploit spatial consumption heterogeneity
  1. Estimate energy expenditure shares at the county level in Germany
  2. Use them with energy prices to construct instrument for local cost shocks
  3. Combine with a 20-year panel of employer-employee registry data
- The empirical results indicate that:
  1. Individuals are able to recover 36% of county-specific cost increases in the same year
  2. Pass-through increases over time: 73% over two years, full over 5 years
  3. Energy price shocks encourage job switches + make them selected for earnings gains

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  - Disutility of labor supply (work longer hours)
  - Cost of Search Effort
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  - Combined with non-homothetic preferences for energy: $L(w - q\bar{e})$
  - Generates positive wage adjustments to energy price shocks as a retainment mechanism

Data Sources: German Statistical Offices and IAB

- Two data sets from the Institute for Employment Research (IAB):
  - BHP: establishment panel drawn from Social Security registry
  - SIEED: 1.5% random sample of BHP; employment history for all their employees (Descriptives)
- Federal Statistical Office: Consumer Expenditure Survey (EVS)
  - Random Samples of $\approx 50{,}000$ households per survey wave (1993, 1998, 2003, 2008, 2013, 2018)
  - Households document expenditures and income for 3 months
- County-Level Characteristics from Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR)

Empirical Framework

Consider the outcome of an individual i, living in county c, in year t:

$$y_{ict} = \alpha_i + \gamma_c + \delta_t + \tau \times C^s_{ct} + \mathbf{X_{ict}}\beta + \varepsilon_{ict},$$

where C^s_{ct} measures an individual's cumulative cost increase due to energy price shocks over period s.

Measure C^s_{ct} as the county-specific energy Consumer Price Index (Laspeyres Approach):

$$C^s_{ct} = \sum_g S^g_{c,t-s} \frac{P^g_t}{P^g_{t-s}},$$

where P^g_t is the price of energy type g and $S^g_{c,t-s}$ is the expenditure share of g.

Identification of τ: Akin to Shift-Share Instrumental Approach

For τ to be identified in the data, it needs to be the case that:

$$C^s_{ct} = \sum_g S^g_{c,t-s} \frac{P^g_t}{P^g_{t-s}} \perp\!\!\!\perp \varepsilon_{ict} | (\alpha_i, \gamma_c, \delta_t, \mathbf{X_{ict}})$$

- ▷ Borusyak, Hull and Jaravel (2022): Identification through exogeneity of shocks
- ▷ Goldsmith-Pinkham, Sorkin and Swift (2020): ... through exogeneity of shares
- ▷ Obvious confounder: local industry composition and local labor market structure

$\Longrightarrow$ Adjust for county-characteristics and their interaction with yearly fixed effects

Identification continued: Household Sorting

- Since energy is a necessity, $S^g_{c,t-s}$ is negatively correlated with local earnings
  - Issue if $\exists$ a shock $Z_t \not\perp \frac{P^g_t}{P^g_{t-s}}$ that differentially affects rich vs. poor

- Approach: use geographic variation adjusted for socio-demographic differences

- Consider expenditure share of energy type g for household h in county c:

$$S^g_{hc} = \pi_c + X'_{hc}\beta + u_{hc}$$

where π_c is a location fixed effect, X'_h contains a set of household characteristics, and $g \in \{Gas, Gasoline, Electricity, Oil, Other\}$.

$\Longrightarrow$ use EVS data to estimate π_c and predict S^g_c, keeping X'_{hc} at sample mean

Energy Expenditures and Shock Exposure: Descriptives

Energy Expenditure Shares across counties

Time Stability | Histogram | Energy Mix

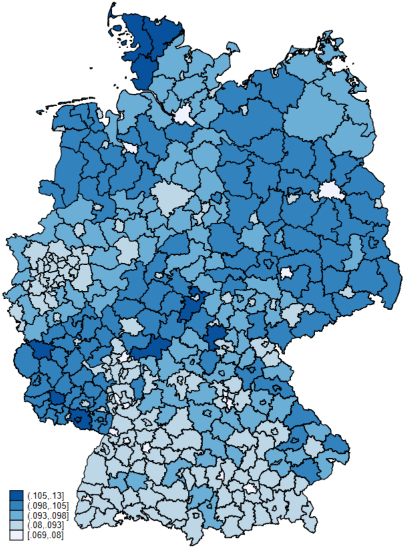


Table: Expenditure Shares for Different Energy Types (in %)

	Mean	*S.D.*	*Min*	*Max*
Gasoline	3.75	0.67	1.79	6.63
Gas	1.25	0.51	0.25	2.76
Oil	0.71	0.37	0.01	2.14
Electricity	2.46	0.35	1.6	3.36
Other Energy	1.13	0.47	0.23	3.27
All Energy	9.31	1.2	6.83	12.74

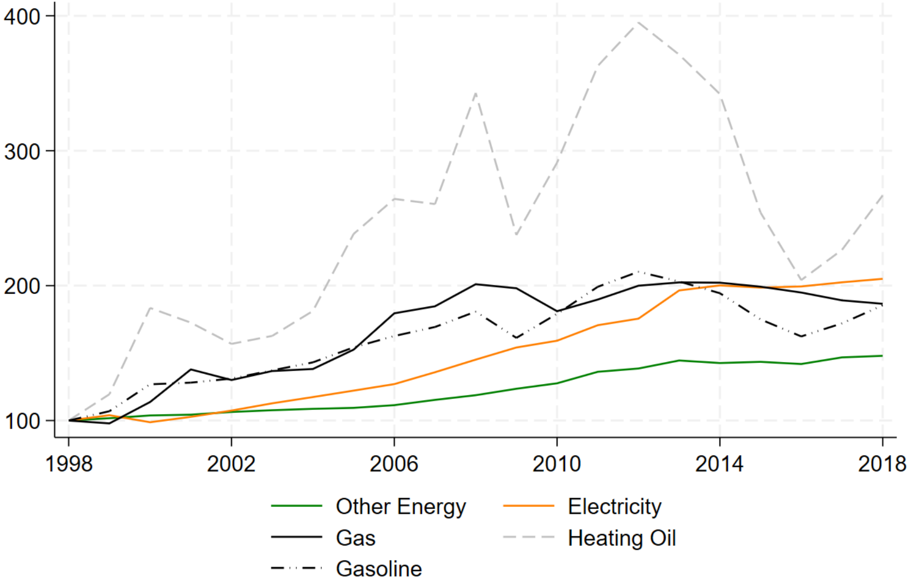
Characterizing High and Low Energy Expenditure Counties

Table: Correlation Coefficients of Expenditure Shares with County Characteristics

	Population	Population Density	Commuter Share
Energy Exp. Share	-0.217	-0.499	0.090
	(0.000)	(0.000)	(0.011)
	New Housing	**Access to Public Transport**	**Dist. to Regional Center**
Energy Exp. Share	-0.189	-0.469	0.689
	(0.000)	(0.000)	(0.000)

Notes: Commuter share is the share of all employees that commute $>$ 50km. Access to Public Transport is the share of inhabitants that live within a 1km radius of a stop for public transport offering at least 20 rides a day. New Housing is the fraction of newly built housing units per 1,000 existing housing units. Distance to Regional Center measures the time in minutes it would require an average inhabitant to reach a regional center (*Oberzentrum*) by car. P-values in parentheses.

Consumer Prices for Energy Types over Sample Period



Energy Cost Shocks and Average Earnings

Average Effect on Earnings

By Energy Type | IV+Leads | Labor Demand

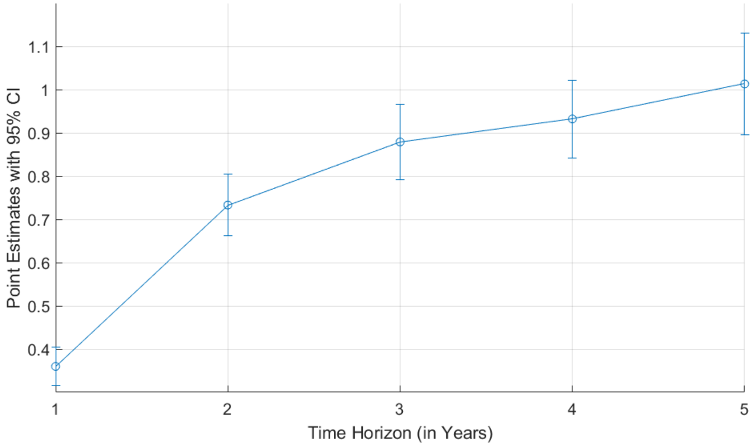
Table: The Effect of Year-to-Year Energy Cost Shocks on Earnings

	$Outcome = ln(earnings_{it}/earnings_{i,t-1})$				
	(1)	(2)	(3)	(4)	(5)
Yearly Cost Shock	0.427***	0.436***	0.361***	0.385***	0.360***
	(0.057)	(0.049)	(0.049)	(0.070)	(0.045)
N Individuals	869,437	869,395	869,379	869,437	868,794
N Total	9,890,000	9,887,582	9,887,145	9,890,000	8,858,287
Match HHI		✓			✓
Match Energy-Intensity			✓		✓
Match Unemployment				✓	✓

Notes: $^{*}p<0.1,^{**}p<0.05,^{***}p<0.01$. Standard errors are clustered at the county level. Yearly Cost Shock is measured as: $C^1_{ct}=\sum_g S^g_{c,t-1}\frac{P^g_t}{P^g_{t-1}}$.

Average Effect on Earnings

Figure: The Effect of Energy Cost Shocks on Income; for varying time-horizons



Adjustment Channels: Why Do Earnings Increase?

The Job-to-Job Mobility Margin

Characterizing Switches

Table: The Effect of Energy Cost Shocks on Job-to-Job Mobility

	Pr(E-to-E)	$\Delta ln(earnings)$	
	(1)	(2)	(3)
Yearly Cost Shock	0.297***	0.268***	0.840***
	(0.120)	(0.035)	(0.218)
Sample	Full	Stayers	Switchers
N Individuals	869,752	805,334	386,020
N Total	9,923,313	8,257,784	1,373,675

- Higher energy costs (i) encourage job mobility and (ii) make transitions more targeted

(Naive) Back-of-the-Envelope Decomposition

- On average, 16% of the sample switches employers in a given year
- For the average switcher (stayer) in the sample, $ln\left(\frac{Earnings_{ict}}{Earnings_{ic,t-1}}\right) = 0.06\ (0.024)$
- Based on this and the estimates on the previous slide:
  1. The increased job mobility explains 3.1% of the average response
  2. More selected transitions explain 37.3% of the average response
  3. The interaction of the two explains $< 1\%$

$\Longrightarrow$ Over half of the response in nominal earnings due to changes for stayers

Other Margins of Adjustment: Extensive Margin

- Aggregate employment responds (weakly) positively; little scope for increase in the MPL
  - 1 S.D. shock $\approx$ 0.1 p.p. lower unemployment rate
- Higher employment + higher earnings suggest presence of labor market frictions

Table: Effect on Aggregate Employment

	$\Delta ln(\#employees)$ (2)	UE Rate (3)
Energy Cost Shock	0.216**	-0.080***
	(0.102)	(0.016)
N Counties	400	400
N Total	8,000	8,000
Data	IAB-BHP	BBSR

Full-time/Part-time

Other Results: Treatment Heterogeneity

- There is considerable pass-through heterogeneity:
  - Younger workers are more mobile and experience stronger earnings responses
  - The same is true for Uni Graduates vs. Non-Graduates
  - Little Difference between genders
- At the same time, job mobility response is:
  - Similar between Eastern and Western Germans, natives and non-citizens
  - Higher for lower levels of education
- E-E transitions are more targeted in high-exposure counties, but within a county, the return is heterogeneous across subgroups

Age Education

Theoretical Implications

- Several potential theoretical channels, but results indicate costly adjustments
- Link from higher costs to targeted transitions implies that transitions are costly
  - Could be because of search frictions
  - Could be because workers care about more than just income: differentiated firms
- Paper follows the second approach and provides simple theory to interpret results
  - Workers with het. tastes in local labor markets + energy and general consumption
  - Think through qualitative implications for welfare + external validity

Model Environment: Baseline Setting

- Set of local labor markets $l \in \{1, 2, ..., L\}$, inhabited by a finite set of firms $j \in J_l$
  - They produce using labor and energy as inputs

- Mass of workers N_l choose:
  1. Which firm j to work for
  2. Consumption of c (produced by firms, sold competitively at p)
  3. Consumption of e (supplied exogenously at price q)

- No savings: firms and workers optimize myopically and locally. Timing:
  1. Realization of productivity and energy price
  2. Firms post wages
  3. Workers observe wage offer distribution and sort
  4. Production and consumption takes place

Worker's Problem I: Consumption, conditional on working for j

Stone-Geary consumption problem when employed at firm j at wage w_{jt}, is:

$$\max_{c_t, e_t} \{\gamma ln(c_t) + (1-\gamma) ln(e_t - \bar{e}_l)\} \quad s.t. \quad p_t c_t + q_t e_t = w_{jt}$$

which delivers:

1. The indirect utility function: $V(w_{jt}, p_t, q_t, \bar{e}) = ln(w_{jt} - q_t \bar{e}) + \Lambda(p_t, q_t) \equiv V_{jt}$
2. The energy expenditure share: $\frac{q_t e_t^*}{w_{jt}} = (1-\gamma) + \gamma \frac{q_t \bar{e}}{w_{jt}}$

Worker's Problem II: Choosing Firm j

Combine this consumption problem with modern monopsony models of differentiated firms (Card et al., 2018; Chan et al., 2024; Lamadon, Mogstad and Setzler, 2022; Berger, Herkenhoff and Mongey, 2022):

$$j(it) = \max_j \{ V_{jt} + \bar{\xi}_j + \xi_{ijt} \}$$

- $\bar{\xi}_j$: average evaluation of firms across workers; gives rise to compensating differentials

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    - Let η govern the dispersion of ξ_{ijt}

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The assumed taste-shock distribution and the value function from the previous slide imply:

$$Pr(j) = \frac{exp(\eta V_{jt} + \eta \bar{\xi}_j)}{\sum_{j' \in J} exp(\eta V_{j't} + \eta \bar{\xi}_{j'})}$$

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$$Pr(j) = \frac{exp(\eta V_{jt} + \eta \bar{\xi}_j)}{\sum_{j' \in J} exp(\eta V_{j't} + \eta \bar{\xi}_{j'})} \implies log\left(\frac{Pr(j|w_j = w)}{Pr(k|w_k = w)}\right) = \eta[\bar{\xi}_j - \bar{\xi}_k]$$

Firm's Problem

Firms produce c using labor and energy as inputs:

$$\max_{w_{jt}, E_{jt}} = p_t z_{jt} f_j(L_{jt}, E_{jt}) - w_{jt} L_{jt} - q_t E_{jt}$$

$$\text{s.t.} \quad L_{jt} = N \times Pr(j)$$

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Standard monopsony case: $w_{jt} = \underbrace{\frac{\varepsilon_{jt}}{1+\varepsilon_{jt}}}_{Mark-Down} \times \underbrace{p_t z_{jt} \frac{\partial f_j(L_{jt}, E_{jt})}{\partial L_{jt}}}_{MRPL},$

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- where ε_{jt} is the elasticity of labor supply to firm j at current prices
- If we assume that firms are atomistic (Lamadon, Mogstad and Setzler, 2022), then:

$$\varepsilon_{jt} = \frac{w_{jt}}{Pr(j)} \frac{\partial Pr(j)}{\partial w_{jt}} = \frac{w_{jt}\eta}{w_{jt} - q_t \bar{e}} \implies w_{jt} = \frac{\eta}{1+\eta} MRPL + \frac{1}{1+\eta} q_t \bar{e}$$

Discussion of Baseline Model

- ▷ Main Mechanism: Shock to costs-of-living increases marginal utility of income
  - Increase in labor supply elasticity changes firm-worker rent-sharing in favor of workers
  - But: some workers pay by giving up on amenities

$\Longrightarrow$ Welfare costs not fully described by changes in real consumption
(see also Afrouzi et al., 2024; Guerreiro et al., 2024)

- ▷ Even with little "mobility" in equilibrium: model predicts pos. wage adjustments

Model Estimation: Parameters to be Estimated

For the estimation, I assume that:

1. Firms produce with a Cobb-Douglas production function: $f_j(L_{jt}, E_{jt}) = [L_{jt}^{1-\gamma} E_{jt}^{\gamma}]^{\alpha}$
2. Firm TFP and amenities follow a joint normal:

$$\begin{pmatrix} ln(z) \\ \xi_j \end{pmatrix} \sim \mathcal{N}\left(\mu = \begin{pmatrix} \mu_z \\ \mu_\xi \end{pmatrix}, \Sigma = \begin{pmatrix} \sigma_z^2 & \rho\sigma_z\sigma_\xi \\ \rho\sigma_z\sigma_\xi & \sigma_\xi^2 \end{pmatrix}\right)$$

3. For now: firms are atomistic (do not compete strategically)
4. The empirical model is identified: consider two labor markets that differ only in $\bar{e}$

Given the model structure and assumptions, I need to estimate/calibrate:

$$\Theta = \{ \underbrace{\eta, \mu_\xi, \sigma_\xi}_{\text{Pref. for Firms}}, \underbrace{\mu, \bar{e}_l}_{\text{Pref. for Consumption}}, \underbrace{\alpha, \gamma, \mu_z, \sigma_z}_{\text{Production Technology}}, \rho \}$$

Model Estimation: Simulated Method of Moments

My empirical analysis generates target moments in the form of differences in responses to energy cost shocks across space. I target these moments for estimation (indirect inference). If they identify causal moments, then I can:

1. Simulate the same set of workers and firms for two labor markets ($\bar{e}_H > \bar{e}_L$)
2. Solve labor market equilibrium for two periods with varying energy prices
3. Use differences in adjustments to infer utility parameters

Estimated Internally		Normalization/External Calibration		
Parameter	Target	Parameter	Value	Target
$\bar{e}_l$	Energy exp. shares	μ_ξ	0	Normalization
μ_z	Mean(wage)	μ	0.93	Total Exp. Coefficient in HH Expenditure Regression
σ_z	Var(wage)	γ	0.03	von Graevenitz and Rottner (2023)
η	Effect of Cost Shock on Δ Earnings + Pr(Switch)	α	0.79	Lamadon, Mogstad and Setzler (2022)
σ_ξ	Var(Firm Size|Wages)			
ρ	Pass-through| Switching			

Estimation Results: very preliminary and off...

Target	Data	Model
ΔPass-Through	0.42	0.15
ΔPr(Switching)	0.30	0.08
ΔPass-Through$\mid$ Switching	0.84	0.84
Mean(Wage)	98.28	96.77
SD(Wage)	63.22	64.10
SD(Firm Size)	122.61	101.92
SD(Firm Size$\mid$Wage)	122.09	15.33

Final Comments and Contribution I

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- Highlight job-to-job mobility as one mitigating channel

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  - Precautionary search (e.g., Blundell, Pistaferri and Preston, 2008; Faia, Shabalina and Wiczer, 2024)
  - Job ladder dynamics (e.g., Topel and Ward, 1992; Moscarini and Postel-Vinay, 2016)

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- Recent series of papers models labor supply responses to inflation

  (Afrouzi et al., 2024; Bloesch, Lee and Weber, 2024; Bostanci, Koru and Villalvazo, 2022; Pilossoph and Ryngaert, 2023)

  $\Longrightarrow$ Focus on consumption heterogeneity instead of general price level
  $\Longrightarrow$ Provide causal evidence from large-scale dataset
  $\Longrightarrow$ Pass-through also for job stayers (Search model vs. differentiated firms)

Final Comments and Contribution II

- A recent macro literature models consumption heterogeneity + price shocks in GE (Bobasu, Dobrew and Repele, 2024; Cardullo and Sechi, 2023; Kuhn, Kehrig and Ziebarth, 2021)
  - $\Longrightarrow$ My results indicate that endogenous labor market adjustments are not second order
  - $\Longrightarrow$ Important to model realistic labor supply responses to think about welfare

- Some work on optimal monetary and fiscal policy response during CoL crises (Olivi, Sterk and Xhani, 2023; Gnocato, 2023; Pieroni, 2023)
  - $\Longrightarrow$ Endogenous buffer for workers: less need for aggressive policy response
  - $\Longrightarrow$ But: recovery is heterogeneous (young vs. old, high vs. low education): targeted policies

Thank You!

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Stability of County Predictions over Time

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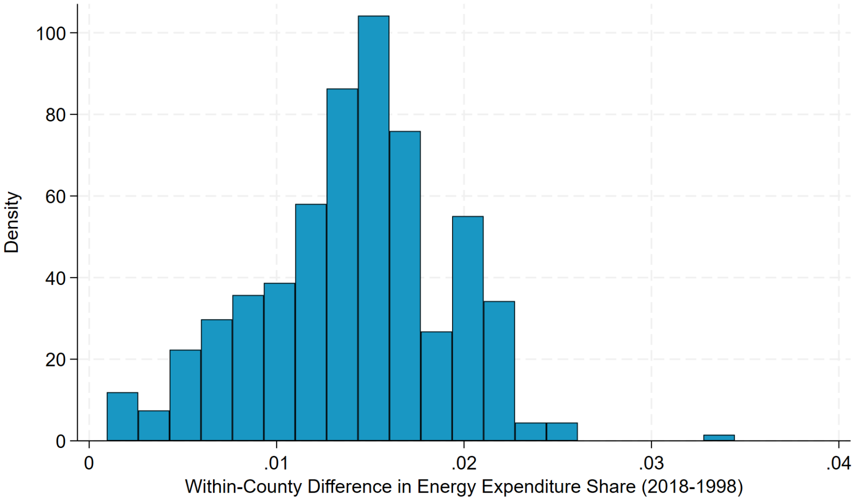

Distribution of Energy Shares Across Counties and Years

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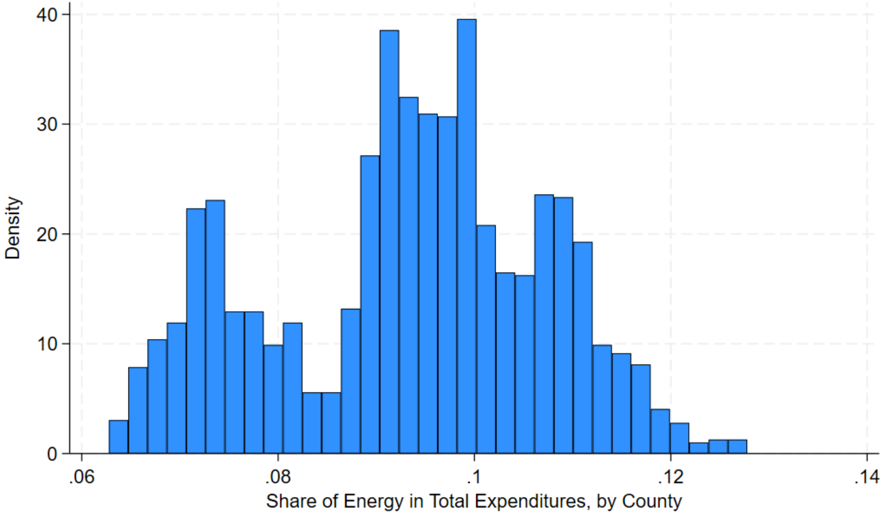

Energy Mix is Stable Across Expenditure Levels

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Table: Share of Energy Types in Total Energy Expenditures (in %)

	Bins of Energy Expenditure Shares (%)			
	$[6.8, 8.3]$	$[8.3, 9.8]$	$[9.8, 11.3]$	$[11.3, 12.7]$
Gasoline	39.9	39.2	41.6	41.4
Gas	11.3	12.9	15.0	15.2
Oil	5.7	7.4	8.9	9.0
Electricity	27.3	27.1	25.5	24.7
Other Energy	15.7	13.2	8.9	9.7

Notes: The table shows estimated county-level averages for expenditure shares of different types of energy goods relative to total energy expenditures. Based on EVS waves 1993, 1998, 2003, 2008, 2013, and 2018. *Other Energy* includes expenditures for coal, wood, other solid fuels, and central heating.

Summary Statistics for Expenditure Shares

Energy Mix Back

Table: Expenditure Shares for Different Energy Types (in %)

	Mean	*S.D.*	*Min*	*Max*
Gasoline	3.75	0.67	1.79	6.63
Gas	1.25	0.51	0.25	2.76
Oil	0.71	0.37	0.01	2.14
Electricity	2.46	0.35	1.6	3.36
Other Energy	1.13	0.47	0.23	3.27
All Energy	9.31	1.2	6.83	12.74

Notes: The table shows estimated county-level averages for expenditure shares of different types of energy goods, based on EVS waves 1993, 1998, 2003, 2008, 2013, and 2018. *Other Energy* includes expenditures for coal, wood, other solid fuels, and central heating.

Effect of Cost Shocks on Earnings, Robustness

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Table: The Effect of Year-to-Year Energy Cost Shocks on Earnings

	$Outcome = ln(earnings_{it}/earnings_{i,t-1})$			
	(1)	(2)	(3)	(4)
Yearly Cost Shock	0.536***	0.428***	0.417***	0.423***
	(0.064)	(0.060)	(0.062)	(0.065)
1st Lead Cost Shock			-0.009	-0.019
			(0.056)	(0.075)
2nd Lead Cost Shock				0.008
				(0.059)
	Carbon IV	Top-Coded Wages		

Notes: $^{*}p < 0.1, ^{**}p < 0.05, ^{***}p < 0.01$. Standard errors are clustered at the county level. Yearly Cost Shock is measured as: $C^1_{ct} = \sum_g S^g_{c,t-1} \frac{P^g_t}{P^g_{t-1}}$.

Labor Demand Responses

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- von Graevenitz and Rottner (2023): 2-3% of total costs due to energy
  - Estimates are for the German manufacturing sector between 2003 and 2017
  - Mostly driven by electricity and gas
  - Excluding gas or electricity does not affect results ▷
- Petrick, Rehdanz and Wagner (2011) identify sectors with highest within-sector variance of energy intensity
  - These are the sectors that are most likely to be problematic (allow for variation across space)
  - Excluding counties with high/low share of employment in these sectors does not affect results ▷

Effect of Cost Shocks on Earnings, by Energy Type

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Table: The Effect of Year-to-Year Energy Cost Shocks on Earnings

		Exclude:				
		Gasoline	Gas	Oil	Electricity	Other Energy
Yearly Cost Shock		0.505***	0.452***	0.489***	0.484***	0.357***
		(0.074)	(0.069)	(0.069)	(0.060)	(0.059)
Gasoline	0.563***					
	(0.094)					
Gas	0.523***					
	(0.124)					
Oil	0.240***					
	(0.092)					
Electricity	0.133					
	(0.211)					
Other Energy	0.468**					
	(0.191)					

Notes: $^{*}p < 0.1,^{**}p < 0.05,^{***}p < 0.01$. Standard errors are clustered at the county level. Yearly Cost Shock is measured as: $C^1_{ct} = \sum_g S^g_{c,t-1} \frac{P^g_t}{P^g_{t-1}}$.

Variance in Energy-Intensity within Sectors

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Table: Pass-Through When Dropping Counties with High (Low) Share of Employment in Sectors with High Variance in Energy-Intensity

	$Outcome = ln(earnings_{it}/earnings_{i,t-1})$			
	(1)	(2)	(3)	(4)
Yearly Cost Shock	0.427^{***}	0.404^{***}	0.388^{***}	0.389^{***}
	(0.057)	(0.061)	(0.064)	(0.053)
	Full	Drop Top 10%	Drop Top 20%	Drop Bottom & Top 10%

Notes: $^{*}p < 0.1, ^{**}p < 0.05, ^{***}p < 0.01$. Standard errors are clustered at the county level. Yearly Cost Shock is measured as: $C^1_{ct} = \sum_g S^g_{c,t-1} \frac{P^g_t}{P^g_{t-1}}$.

Effect Heterogeneity by Age

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Table: Effect of Energy Cost Shock on Earnings and Job Mobility, by Age

Outcome	Early (age 25-40)	Mid (41-55)	Late (56-65)
$\Delta ln(income), yearly$	0.665***	0.190***	-0.030
	(0.119)	(0.041)	(0.126)
$Pr(E-E), yearly$	0.398**	0.177	0.009
	(0.141)	(0.123)	(0.213)
N Individuals	568,595	521,052	205,405

Why Are Transitions More Effective in High-Exposure Counties?

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Table: Energy Cost Shocks and the Characteristics of Switcher's New Firms

	Expected Change in:	*Pr*(Switch to Different:)		
	ln(*earnings*)	Sector	Occupation	Task
Energy Cost Shock	0.343*	0.573***	0.487***	0.089
	(0.181)	(0.182)	(0.169)	(0.135)

Effect Heterogeneity by Educational Attainment

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Table: Effect of Energy Cost Shock on Earnings and Job Mobility, by Education

Outcome	Below Abitur	Abitur	Academic
$\Delta ln(income), yearly$	0.295***	0.291***	0.718***
	(0.044)	(0.109)	(0.103)
$Pr(E-E), yearly$	0.252**	0.022	0.446***
	(0.116)	(0.184)	(0.157)
N Individuals	610,794	124,986	166,422

Other Margins of Adjustment: Intensive Margin

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- No Data on Hours worked, but: limited response of part-time workers